APPENDICES
APPENDIX A1 USEFUL QUANTITIES

Quantity	Symbol	Value[a]
Physical constants		
speed of light in a vacuum	c	$3.00 \times 10^{8}\,\mathrm{m\,s^{-1}}$
Planck constant	h	$6.63 \times 10^{-34}\,\mathrm{J\,s}$
Boltzmann constant	k	$1.38 \times 10^{-23}\,\mathrm{J\,K^{-1}}$
gravitational constant	G	$6.67 \times 10^{-11}\,\mathrm{N\,m^{2}\,kg^{-2}}$
Stefan–Boltzmann constant	σ	$5.67 \times 10^{-8}\,\mathrm{W\,m^{-2}\,K^{-4}}$
charge of electron	$-e$	$-1.60 \times 10^{-19}\,\mathrm{C}$
mass of hydrogen atom	m_{H}	$1.67 \times 10^{-27}\,\mathrm{kg}$
mass of electron	m_{e}	$9.11 \times 10^{-31}\,\mathrm{kg}$
Astronomical constants		
mass of the Earth	M_{E}	$5.98 \times 10^{24}\,\mathrm{kg}$
radius (equatorial) of the Earth	R_{E}	$6.38 \times 10^{6}\,\mathrm{m}$
mass of the Sun	$M_{\odot}$	$1.99 \times 10^{30}\,\mathrm{kg}$
radius of the Sun	$R_{\odot}$	$6.96 \times 10^{8}\,\mathrm{m}$
photospheric temperature of the Sun	$T_{\odot}$	5770K
luminosity of the Sun	$L_{\odot}$	$3.84 \times 10^{26}\,\mathrm{W}$

[a]Values are given to 3 significant figures. Many of these are known more accurately.

Units

Quantity	SI Unit	Other units	In SI	Alternative SI units
length	metre, m	Astronomical unit, AU	$1.50 \times 10^{11}\,\mathrm{m}$	
		parsec, pc	$3.09 \times 10^{16}\,\mathrm{m}$	
time	second, s	year, yr	$3.16 \times 10^{7}\,\mathrm{s}$	
frequency	hertz, Hz			$\mathrm{s^{-1}}$
force	newton, N			$\mathrm{kg\,m\,s^{-2}}$
pressure	pascal, Pa			$\mathrm{kg\,m^{-1}\,s^{-2}}$, $\mathrm{N\,m^{-2}}$
temperature	kelvin, K	℃	(kelvin – 273)	
energy	joule, J	electronvolt, eV	$1.60 \times 10^{-19}\,\mathrm{J}$	$\mathrm{kg\,m^{2}\,s^{-2}}$
power	watt, W			$\mathrm{kg\,m^{2}\,s^{-3}}$, $\mathrm{J\,s^{-1}}$
angle	radian, rad	degree, °	1/57.3 rad	
		1° = 60 arcmin = 3600 arcsec		
		arcsec, ″	1/206265 rad	

APPENDIX A2
STELLAR NOMENCLATURE

The brightest stars in a constellation are referred to by Greek letters (usually, but not always) in order of brightness followed by a constellation designation shortened to three letters. For example, Betelgeuse in the constellation of Orion is referred to as α Ori (alpha Orionis).

The Greek alphabet

Name	Pronounced	Lower case	Upper case	Name	Pronounced	Lower case	Upper case
alpha		α	A	nu	new	ν	N
beta	bee-ta	β	B	xi	cs-eye	ξ	Ξ
gamma		γ	Γ	omicron		ο	O
delta		δ	Δ	pi	pie	π	Π
epsilon		ε	E	rho	roe	ρ	P
zeta	zee-ta	ζ	Z	sigma		σ	Σ
eta	ee-ta	η	H	tau		τ	T
theta	thee-ta (th as in theatre)	θ	Θ	upsilon		υ	Y
iota	eye-owe-ta	ι	I	phi	fie	ϕ	Φ
kappa		κ	K	chi	kie	χ	X
lambda	lam-da	λ	Λ	psi	ps-eye	ψ	Ψ
mu	mew	μ	M	omega	owe-me-ga	ω	Ω

The constellations

No.	Abbr.	Name	Genitive	English name	Region[a]
1	And	Andromeda	Andromedae	Andromeda	N
2	Ant	Antlia	Antliae	Air Pump	S
3	Aps	Apus	Apodis	Bird of Paradise	S
4	Aqr	Aquarius	Aquarii	Water Carrier	Eq
5	Aql	Aquila	Aquilae	Eagle	Eq
6	Ara	Ara	Arae	Alter	S
7	Ari	Aries	Arietis	Ram	E
8	Aur	Auriga	Aurigae	Charioteer	N
9	Boo	Bootes	Bootis	Herdsman	NEq
10	Cae	Caelum	Caeli	Chisel	S
11	Cam	Camelopardalis[b]	Camelopardalis[b]	Giraffe	N

No.	Abbr.	Name	Genitive	English name	Region[a]
12	Cnc	Cancer	Cancri	Crab	Eq
13	CVn	Canes Venatici	Canes Venaticorum	Hunting Dogs	N
14	CMa	Canis Major	Canis Majoris	Great Dog	Eq
15	CMi	Canis Minor	Canis Minoris	Small Dog	Eq
16	Cap	Capricornus	Capricorni	Goat (Capricorn)	Eq
17	Car	Carina[c]	Carinae	Keel	S
18	Cas	Cassiopeia	Cassiopeiae	Cassiopeia	N
19	Cen	Centaurus	Centauri	Centaur	S
20	Cep	Cepheus	Cephei	Cepheus	N
21	Cet	Cetus	Ceti	Whale	Eq
22	Cha	Chameleon	Chameleontis	Chamelion	S
23	Cir	Circinus	Circini	Compasses	S
24	Col	Columba	Columbae	Dove	S
25	Com	Coma Berenices	Comae Berenices	Berenice's Hair	Eq
26	CrA	Corona Australis	Coronae Australis	Southern Crown	S
27	CrB	Corona Borealis	Coronae Borealis	Northern Crown	N
28	Crv	Corvus	Corvi	Crow	Eq
29	Crt	Crater	Crateris	Cup	Eq
30	Cru	Crux	Crucis	Southern Cross	S
31	Cyg	Cygnus	Cygni	Swan	N
32	Del	Delphinus	Delphini	Dolphin	Eq
33	Dor	Dorado	Doradus	Goldfish	S
34	Dra	Draco	Draconis	Dragon	N
35	Equ	Equuleus	Equulei	Small Horse	Eq
36	Eri	Eridanus	Eridani	River	EqS
37	For	Fornax	Fornacis	Furnace	EqS
38	Gem	Gemini	Geminorum	Twins	Eq
39	Gru	Grus	Gruis	Crane	S
40	Her	Hercules	Herculis	Hercules	NEq
41	Hor	Horologium	Horologii	Clock	S
42	Hya	Hydra	Hydrae	Water Monster	Eq
43	Hyi	Hydrus	Hydri	Sea Serpent	S

No.	Abbr.	Name	Genitive	English name	Region[a]
44	Ind	Indus	Indi	Indian	S
45	Lac	Lacerta	Lacertae	Lizard	N
46	Leo	Leo	Leonis	Lion	Eq
47	LMi	Leo Minor	Leonis Minoris	Small Lion	N
48	Lep	Lepus	Leporis	Hare	Eq
49	Lib	Libra	Librae	Scales	Eq
50	Lup	Lupus	Lupi	Wolf	S
51	Lyn	Lynx	Lyncis	Lynx	N
52	Lyr	Lyra	Lyrae	Lyre	N
53	Men	Mensa	Mensae	Table (mountain)	S
54	Mic	Microscopium	Microscopii	Microscope	S
55	Mon	Monoceros	Monocerotis	Unicorn	Eq
56	Mus	Musca	Muscae	Fly	S
57	Nor	Norma	Normae	Square	S
58	Oct	Octans	Octantis	Octant	S
59	Oph	Ophiuchus	Ophiuchi	Serpent Bearer	Eq
60	Ori	Orion	Orionis	Orion (Hunter)	Eq
61	Pav	Pavo	Pavonis	Peacock	S
62	Peg	Pegasus	Pegasi	Winged Horse	Eq
63	Per	Perseus	Persei	Perseus	N
64	Phe	Phoenix	Phoenicis	Phoenix	S
65	Pic	Pictor	Pictoris	Easel	S
66	Psc	Pisces	Piscium	Fishes	Eq
67	PsA	Pisces Austrinus	Pisces Austrini	Southern Fish	EqS
68	Pup	Puppis[c]	Puppis	Stern	S
69	Pyx	Pyxis	Pyxidis	Compass	EqS
70	Ret	Reticulum	Reticuli	Net	S
71	Sge	Sagitta	Sagittae	Arrow	Eq
72	Sgr	Sagittarius	Sagittarii	Archer	EqS
73	Sco	Scorpius	Scorpii	Scorpion	EqS
74	Scl	Sculptor	Sculptoris	Sculptor	EqS
75	Sct	Scutum	Scuti	Shield	Eq

No.	Abbr.	Name	Genitive	English name	Region[a]
76	Ser	Serpens[d]	Serpentis	Serpent[d]	Eq
77	Sex	Sextans	Sextantis	Sextant	Eq
78	Tau	Taurus	Tauri	Bull	Eq
79	Tel	Telescopium	Telescopii	Telescope	S
80	Tri	Triangulum	Trianguli	Triangle	N
81	TrA	Triangulum Australe	Trianguli Australis	Southern Triangle	S
82	Tuc	Toucana	Toucanae	Toucan	S
83	UMa	Ursa Major	Ursae Majoris	Great Bear	N
84	UMi	Ursa Minor	Ursae Minoris	Little Bear	N
85	Vel	Vela[c]	Velorum	Sails	S
86	Vir	Virgo	Virginis	Virgin	Eq
87	Vol	Volans	Volantis	Flying Fish	S
88	Vul	Vulpecula	Vulpeculae	Fox	Eq

[a]N = Northern sky, Eq = Equatorial sky, S = Southern sky.

[b]Also known as Camelopardus (Camelopardi).

[c]Carina, Vela and Puppis were originally one constellation, Argo.

[d]In two separate parts: Serpens Caput (Head) and Serpens Cauda (Tail).

APPENDIX A3
THE 100 CLOSEST STARS TO THE SUN

The data are taken from the RECONS survey of objects beyond the Solar System within 10 parsecs and are correct at mid July 2002. The positions of objects in the list may change as more accurate measurements are made or faint objects are discovered. Most of the stars are so faint they do not have names and are known by catalogue numbers or their positions. The missing numbers in the first column indicate stars in binary or multiple systems.

	Name	HIP[a]	RA[b]/degrees	Dec[b]/degrees	V[c]	M_V[d]	Sp type[e]	d/pc[f]
1	α Cen C, Proxima	70890	217.43	–62.68	11.09	15.53	M5.5 V	1.295 ± 0.004
	α Cen A, Rigel Kent	71683	219.90	–60.83	0.01	4.38	G2 V	1.338 ± 0.001
	α Cen B, Rigel Kent	71681	219.90	–60.84	1.34	5.71	K0 V	1.338 ± 0.001
4	Barnard's star	87937	269.45	4.67	9.53	13.22	M4 V	1.828 ± 0.003
5	Wolf 359		164.12	7.02	13.44	16.55	M6 V	2.386 ± 0.012
6	Lalande 21185	54035	165.84	35.98	7.47	10.44	M2 V	2.542 ± 0.005
7	α CMa A, Sirius A	32349	101.29	–16.71	–1.43	1.47	A1 V	2.631 ± 0.009
	α CMa B, Sirius B		101.29	–16.71	8.44	11.34	WD	2.631 ± 0.009
9	–[g]		24.76	–17.95	12.54	15.40	M5.5 V	2.68 ± 0.02
	–[g]		24.76	–17.95	12.99	15.85	M6 V	2.68 ± 0.02
11	–[g]	92403	282.45	–23.85	10.43	13.07	M3.5 V	2.968 ± 0.016
12	–[g]		355.48	44.18	12.29	14.79	M5.5 V	3.165 ± 0.011
13	ε Eri	16537	53.24	–9.46	3.73	6.18	K2 V	3.226 ± 0.008
14	–[g]	114046	346.45	–35.86	7.34	9.75	M1.5 V	3.293 ± 0.009
15	–[g]	57548	176.93	0.81	11.13	13.51	M4 V	3.348 ± 0.015
16	–[g]		339.64	–15.30	13.33	15.64	M5 V	3.45 ± 0.05
	–[g]		339.64	–15.30	13.27	15.58		3.45 ± 0.05
	–[g]		339.64	–15.30	14.03	16.34		3.45 ± 0.05
19	α CMi A, Procyon A	37279	114.83	5.23	0.38	2.66	F5 IV–V	3.496 ± 0.010
	α CMi B, Procyon B		114.83	5.23	10.70	12.98	WD	3.496 ± 0.010
21	61 Cyg A	104214	316.71	38.74	5.21	7.49	K5 V	3.496 ± 0.007
	61 Cyg B	104217	316.71	38.74	6.03	8.31	K7 V	3.496 ± 0.007
23	–[g]	91768	280.70	59.63	8.90	11.16	M3 V	3.53 ± 0.02
	–[g]	91772	280.70	59.63	9.69	11.95	M3.5 V	3.53 ± 0.02

	Name	HIP[a]	RA[b]/degrees	Dec[b]/degrees	V[c]	M_V[d]	Sp type[e]	d/pc[f]
25	–[g]	1475	4.59	44.02	8.08	10.32	M1.5 V	3.563 ± 0.012
	–[g]		4.59	44.02	11.06	13.30	M3.5 V	3.563 ± 0.012
27	ε Ind	108870	330.82	–56.78	4.69	6.89	K5 V	3.625 ± 0.009
28	–[g]		127.46	26.78	14.78	16.98	M6.5 V	3.63 ± 0.04
29	τ Cet	8102	26.02	–15.94	3.49	5.68	G8 V	3.644 ± 0.010
30	–[g]		54.00	–44.51	13.03	15.21	M5.5 V	3.68 ± 0.02
31	–[g]	5643	18.13	–17.00	12.02	14.17	M4.5 V	3.72 ± 0.04
32	Luyten's star	36208	111.85	5.24	9.86	11.97	M3.5 V	3.79 ± 0.02
33	Kapteyn's star	24186	77.90	–45.00	8.84	10.87	M1.5 V	3.917 ± 0.013
34	–[g]	105090	319.32	–38.87	6.67	8.69	M0 V	3.95 ± 0.02
35	Kruger 60	110893	337.00	57.70	9.79	11.76	M3 V	4.03 ± 0.02
	–[g]		337.00	57.70	11.41	13.38	M4 V	4.03 ± 0.02
37	–[g]	30920	97.35	–2.81	11.15	13.09	M4.5 V	4.09 ± 0.03
	–[g]		97.35	–2.81	14.23	16.17		4.09 ± 0.03
39	–[g]	80824	247.58	–12.66	10.07	11.93	M3 V	4.24 ± 0.03
40	Van Maanen 2	3829	12.29	5.40	12.38	14.21	WD	4.31 ± 0.03
41	–[g]	439	1.34	–37.35	8.55	10.35	M3 V	4.36 ± 0.02
42	–[g]		188.32	9.02	13.18	14.97	M5.5 V	4.39 ± 0.09
	–[g]		188.32	9.02	13.17	14.96		4.39 ± 0.09
44	–[g]		30.06	13.05	12.27	14.03	M4.5 V	4.45 ± 0.06
45	–[g]		161.13	–61.19	13.92	15.66	M5.5 V	4.5 ± 0.2
46	–[g]	86162	264.11	68.34	9.17	10.89	M3 V	4.54 ± 0.02
47	–[g]		162.05	–11.34	15.60	17.32	M6.5 V	4.54 ± 0.07
48	–[g]	85523	262.17	–46.89	9.38	11.09	M3 V	4.54 ± 0.03
49	–[g]		298.48	44.42	13.46	15.17	M5.5 V	4.54 ± 0.02
	–[g]		298.48	44.42	14.01	15.72	M6 V	4.54 ± 0.02
	–[g]		298.48	44.42	16.75	18.46		4.54 ± 0.02
52	–[g]	57367	176.43	–64.84	11.5	13.18	WD	4.62 ± 0.04
53	–[g]		1.68	–7.54	13.76	15.40	M5.5 V	4.69 ± 0.08
54	–[g]	113020	343.32	–14.26	10.17	11.81	M3.5 V	4.70 ± 0.04
	–[g]		343.32	–14.26			planet?	4.70 ± 0.04

	Name	HIP[a]	RA[b]/degrees	Dec[b]/degrees	V[c]	M_V[d]	Sp type[e]	d/pc[f]
56	–[g]	54211	166.38	43.52	8.77	10.34	M1 V	4.85 ± 0.03
	–[g]		166.38	43.52	14.48	16.05	M5.5 V	4.85 ± 0.03
58	–[g]	49908	152.85	49.46	6.59	8.16	K7 V	4.86 ± 0.02
59	–[g]		154.90	19.87	9.32	10.87	M3 V	4.89 ± 0.07
60	–[g]	106440	323.39	–49.01	8.66	10.20	M3 V	4.93 ± 0.03
61	–[g]		54.90	–35.43	18.50	20.02	M9 V	4.97 ± 0.10
62	–[g]	86214	264.27	–44.32	10.95	12.45	M4.5 V	5.01 ± 0.06
63	–[g]	19849	63.82	–7.65	4.43	5.92	K1 V	5.03 ± 0.02
	–[g]		63.82	–7.65	9.52	11.01	WD	5.03 ± 0.02
	–[g]		63.82	–7.65	11.19	12.68	M4.5 V	5.03 ± 0.02
66	–[g]	112460	341.71	44.34	10.22	11.70	M3.5 V	5.05 ± 0.04
67	70 Oph	88601	271.36	2.50	4.20	5.66	K0 V	5.10 ± 0.02
	–[g]		271.36	2.50	6.05	7.51	K5 V	5.10 ± 0.02
69	α Aql	97649	297.70	8.87	0.77	2.22	A7 IV–V	5.13 ± 0.02
70	–[g]		134.56	19.76	14.06	15.47	M5.5 V	5.23 ± 0.07
	–[g]		134.56	19.76	14.92	16.33		5.23 ± 0.07
72	–[g]		90.02	2.71	11.33	12.68	M3.5 V	5.37 ± 0.3
73	–[g]	57544	176.91	78.69	10.79	12.14	M3.5 V	5.38 ± 0.04
74	–[g]	1242	3.87	–16.13	11.58	12.93	M4 V	5.38 ± 0.09
	–[g]		3.87	–16.13	14.33	15.68		5.38 ± 0.09
76	–[g]	67155	206.43	14.90	8.46	9.79	M1.5 V	5.43 ± 0.03
	–[g]		75.49	–6.95	12.15	13.46	M3.5 V	5.47 ± 0.10
78	–[g]	103039	313.14	–16.98	11.41	12.71		5.49 ± 0.11
79	–[g]	21088	67.79	58.98	11.04	12.32	M4 V	5.54 ± 0.02
	–[g]		67.79	58.98	12.44	13.72	WD	5.54 ± 0.02
81	–[g]	33226	103.71	33.27	10.02	11.29	M3 V	5.57 ± 0.05
82	–[g]		290.20	–45.56	12.23	13.45	M4.5 V	5.71 ± 0.3
83	–[g]	25878	82.86	–3.67	7.95	9.17	M1.5 V	5.71 ± 0.03
84	σ Dra	96100	293.09	69.67	4.68	5.88	K0 V	5.761 ± 0.014
85	–[g]	29295	92.65	–21.86	8.12	9.31	M1 V	5.77 ± 0.04

	Name	HIP[a]	RA[b]/degrees	Dec[b]/degrees	V[c]	M_V[d]	Sp type[e]	d/pc[f]
	–[g]		92.65	–21.86			BD	5.77 ± 0.04
87	–[g]	86990	266.65	–57.32	10.75	11.92	M4 V	5.82 ± 0.07
88	–[g]	94761	289.23	5.17	9.11	10.28	M3 V	5.85 ± 0.02
	–[g]		289.23	5.17	17.50	18.67	M8 V	5.85 ± 0.02
90	–[g]	26857	85.53	12.49	11.51	12.67	M4 V	5.87 ± 0.11
	–[g]		123.17	–21.55	12.07	13.22	M3.5 V	5.89 ± 0.5
92	–[g]	73184	224.36	–21.41	5.75	6.90	K5 V	5.89 ± 0.03
	–[g]		224.36	–21.41	8.28	9.43	M1 V	5.89 ± 0.03
	–[g]		224.36	–21.41	10.05	11.20		5.89 ± 0.03
	–[g]		224.36	–21.41			BD	5.89 ± 0.03
96	–[g]	117473	357.30	2.40	8.99	10.12	M1 V	5.93 ± 0.05
97	η Cas	3821	12.27	57.82	3.45	4.58	G3 V	5.94 ± 0.02
	–[g]		12.27	57.82	7.51	8.64	K7 V	5.94 ± 0.02
99	–[g]	76074	233.06	–41.27	9.31	10.44	M3 V	5.94 ± 0.05
100	–[g]		116.17	3.55	11.19	12.31	M4 V	5.97 ± 0.08

[a] Hipparcos catalogue number for those stars detected by Hipparcos.

[b] Coordinate system fixed with respect to the stars. Right Ascension and Declination at the beginning of the year 2000. RA usually has units of hours, minutes and seconds but degrees are often used in computer databases.

[c] Apparent visual magnitude (Section 3.3.3).

[d] Absolute visual magnitude (Section 3.3.3).

[e] Spectral type (Section 3.3.2): WD = White dwarf, BD = Brown dwarf.

[f] Distance from the Sun in parsecs (Section 3.2.2).

[g] Unnamed star.

Data adapted from RECONS: Research Consortium on Nearby Stars
http://www.chara.gsu.edu/~thenry/RECONS/
and ESA, The Hipparcos Space Astrometry Mission
http://astro.estec.esa.nl/Hipparcos

Appendix A4
The 100 brightest stars visible from Earth

This list gives the 100 'stars' with the lowest apparent visual magnitudes as measured by Hipparcos. In many cases these stars are binary or multiple systems which cannot be separated with the unaided eye. Often one star is much brighter than the other(s) so the apparent magnitude of this star is indistinguishable from that of the combined system and the spectrum is dominated by the brightest component. The binary designation is only shown when the stars have been detected individually by Hipparcos. The values of apparent visual magnitude V, (and hence position in the list), absolute visual magnitude M_V and distance as measured by Hipparcos differ in detail from those in other catalogues and Appendix A3. These differences illustrate the uncertainties in measurements obtained from different sources. In particular, if the distance is highly uncertain then the absolute magnitude derived using it may differ significantly from that expected for the particular spectral type. No account has been taken of interstellar absorption in calculation of the absolute magnitudes.

	Name	HIP[a]	RA[b]/degrees	Dec[b]/degrees	Bin[c]	V[d]	M_V[e]	Sp type[f]	d/pc[g]
1	α CMa Sirius	32349	101.29	–16.71	1	–1.44	1.45	A1 V	2.64 ± 0.01
2	α Car Canopus	30438	95.99	–52.70		–0.62	–5.53	F0 II	96 ± 5
3	α Boo Arcturus	69673	213.92	19.19		–0.05	–0.31	K1.5 III	11.26 ± 0.09
4	α Cen A Rigel Kent	71683	219.92	–60.84	1	–0.01	4.34	G2 V	1.347 ± 0.003
5	α Lyr Vega	91262	279.23	38.78	1	0.03	0.58	A0 V	7.76 ± 0.03
6	α Aur Capella	24608	79.17	46.00	1+2	0.08	–0.48	G5 III + G0 III	12.9 ± 0.2
7	β Ori Rigel	24436	78.63	–8.20	1	0.18	–6.69	B8 I	237 ± 50
8	α CMi Procyon	37279	114.83	5.23	1	0.40	2.68	F5 IV–V	3.50 ± 0.01
9	α Ori Betelgeuse	27989	88.79	7.41	1 *	0.45	–5.14	M2 I	131 ± 30
10	α Eri Achernar	7588	24.43	–57.24		0.45	–2.77	B3 V	44 ± 1
11	β Cen Hadar	68702	210.96	–60.37	1	0.61	–5.42	B1 III	161 ± 14
12	α Aql Altair	97649	297.70	8.87	1	0.76	2.20	A7 V	5.14 ± 0.03
13	α Cru Acrux	60718	186.65	–63.10	1+2	0.77	–4.19	B0.5IV + B1 V	98 ± 7
14	α Tau Aldebaran	21421	68.98	16.51	1 *	0.87	–0.63	K5 III	20 ± 0.4
15	α Vir Spica	65474	201.30	–11.16	1	0.98	–3.55	B1 III	80 ± 6
16	α Sco Antares	80763	247.35	–26.43	1+2 *	1.06	–5.28	M1.5 I + B4 V	185 ± 60
17	β Gem Pollux	37826	116.33	28.03	1	1.16	1.09	K0 III	10.34 ± 0.09
18	α PsA Fomalhaut	113368	344.41	–29.62		1.17	1.74	A3 V	7.69 ± 0.05
19	α Cyg Deneb	102098	310.36	45.28	1	1.25	–8.73	A2 I	990 ± 560
20	β Cru Mimosa	62434	191.93	–59.69	1	1.25	–3.92	B0.5 III	108 ± 7
21	α Cen B Rigel Kent	71681	219.91	–60.84	2	1.35	5.70	K1 V	1.347 ± 0.003

	Name	HIP[a]	RA[b]/degrees	Dec[b]/degrees	Bin[c]	V[d]	M_V[e]	Sp type[f]	d/pc[g]
22	α Leo Regulus	49669	152.09	11.97	1	1.36	–0.52	B7 V	23.8 ± 0.5
23	ε CMa Adhara	33579	104.66	–28.97	1	1.50	–4.10	B2 II	132 ± 10
24	α Gem Castor	36850	113.65	31.89	1+2	1.58	0.59	A1 V + A2 V	15.8 ± 0.3
25	γ Cru Gacrux	61084	187.79	–57.11	1	1.59	–0.56	M3.5 III	27.0 ± 0.5
26	λ Sco Shaula	85927	263.40	–37.10	1	1.62	–5.05	B2 IV	216 ± 40
27	γ Ori Bellatrix	25336	81.28	6.35	1	1.64	–2.72	B2 III	75 ± 5
28	β Tau Alnath	25428	81.57	28.61	1	1.65	–1.37	B7 III	40 ± 1
29	β Car Miaplacidus	45238	138.30	–69.72		1.67	–0.99	A2 IV	34.1 ± 0.6
30	ε Ori Alnilam	26311	84.05	–1.20	1	1.69	–6.38	B0 I	410 ± 150
31	α Gru Alnair	109268	332.06	–46.96	1	1.73	–0.73	B7 IV	31.1 ± 0.8
32	ζ Ori Alnitak	26727	85.19	–1.94	1	1.74	–5.26	O9 I	251 ± 50
33	γ Vel Regor	39953	122.38	–47.34	1+2 *	1.75	–5.31	W + O7.5	258 ± 35
34	ε UMa Alioth	62956	193.51	55.96		1.76	–0.21	A0	24.8 ± 0.4
35	ε Sgr Kaus Australis	90185	276.04	–34.38	1	1.79	–1.44	B9.5 III	44 ± 2
36	α Per Mirphak	15863	51.08	49.86	1	1.79	–4.50	F5 I	181 ± 20
37	α UMa Dubhe	54061	165.93	61.75	1	1.81	–1.08	K0 III	37.9 ± 0.7
38	δ CMa Al Wazor	34444	107.10	–26.39		1.83	–6.87	F8 I	550 ± 170
39	η UMa Alkaid	67301	206.89	49.31		1.85	–0.60	B3 V	30.9 ± 0.7
40	θ Sco Sargas	86228	264.33	–43.00		1.86	–2.75	F1 II	83 ± 6
41	ε Car She	41037	125.63	–59.51	1+2	1.86	–4.58	K3 III + B2 V	194 ± 20
42	β Aur Menkalinam	28360	89.88	44.95	1	1.90	–0.10	A2 IV	25.2 ± 0.5
43	α Tr Ras Al Muthallath	82273	252.17	–69.03		1.91	–3.62	K2 II–III	127 ± 10
44	δ Vel Koo She	42913	131.18	–54.71	1	1.93	–0.01	A1 V	24.5 ± 0.2
45	γ Gem Alhena	31681	99.43	16.40	1	1.93	–0.60	A0 IV	32 ± 2
46	α Pav Joo Tseo	100751	306.41	–56.74	1	1.94	–1.81	B2 IV	56 ± 2
47	α UMi Polaris	11767	37.95	89.26	1 *	1.97	–3.64	F7 I	132 ± 8
48	β CMa Murzim	30324	95.68	–17.96	1	1.98	–3.95	B1 II-III	153 ± 15
49	α Hya Alphard	46390	141.90	–8.66	1	1.99	–1.69	K3II-III	54 ± 2
50	γ Leo Algieba	50583	154.99	19.84	1+2	2.01	–0.92	K1 III + G7 III	38.5 ± 1.2
51	α Ari Hamal	9884	31.79	23.46		2.01	0.48	K2 III	20.2 ± 0.4
52	β Cet Diphda	3419	10.90	–17.99		2.04	–0.30	G9.5 III	29.4 ± 0.7
53	σ Sgr Nunki	92855	283.82	–26.30	1	2.05	–2.14	B2.5 V	69 ± 4

	Name	HIP[a]	RA[b]/degrees	Dec[b]/degrees	Bin[c]	V[d]	M_V[e]	Sp type[f]	d/pc[g]
54	θ Cen Haratan	68933	211.67	–36.37	1	2.06	0.70	K0 III	18.7 ± 0.3
55	κ Ori Saiph	27366	86.94	–9.67		2.07	–4.65	B0.5 I	221 ± 40
56	α And (δ Peg) Alpheratz	677	2.10	29.09	1	2.07	–0.30	B8 IV	29.8 ± 0.7
57	β Gru Al Dhanab	112122	340.67	–46.89	*	2.07	–1.52	M5 III	52 ± 2
58	β And Mirach	5447	17.43	35.62	1	2.07	–1.86	M0 III	61 ± 3
59	β UMi Kocab	72607	222.68	74.16	1	2.07	–0.87	K4 III	38.8 ± 0.8
60	α Oph Rasalhague	86032	263.73	12.56		2.08	1.30	A5 III	14.3 ± 0.2
61	β Per Algol	14576	47.04	40.96	*	2.09	–0.18	B8 V	28.5 ± 0.7
62	γ And A Alamach	9640	30.98	42.33	1	2.10	–3.08	K3 II	109 ± 9
63	β Leo Denebola	57632	177.27	14.57	1	2.14	1.92	A3 V	11.1 ± 0.1
64	γ Cas Cih	4427	14.18	60.72	1 *	2.15	–4.22	B0 IV	188 ± 20
65	γ Cen Koo Low	61932	190.38	–48.96	1	2.20	–0.81	A1 IV	40 ± 2
66	ζ Pup Suhail Hadar	39429	120.90	–40.00		2.21	–5.95	O5	429 ± 90
67	ι Car Tureis	45556	139.27	–59.28		2.21	–4.42	A8 I	212 ± 21
68	α CrB Alphekka	76267	233.67	26.72	1+2 *	2.22	0.42	A0 V + G5 V	22.9 ± 0.4
69	λ Vel Suhail	44816	137.00	–43.43	1	2.23	–3.99	K4.5 I-II	175 ± 16
70	γ Cyg Sadr	100453	305.56	40.26	1	2.23	–6.12	F8 I	470 ± 110
71	ζ UMa Mizar	65378	200.98	54.93	1	2.23	0.33	A1 V	24.0 ± 0.4
72	α Cas Shedir	3179	10.13	56.54	1	2.24	–1.99	K0 III	70 ± 3
73	γ Dra Etamin	87833	269.15	51.49	1	2.24	–1.04	K5 III	45.2 ± 1.0
74	δ Ori Mintaka	25930	83.00	–0.30	1	2.25	–4.99	O9.5 II	281 ± 65
75	β Cas Caph	746	2.29	59.15	1	2.28	1.17	F2 III-IV	16.7 ± 0.2
76	δ Sco Dschubba	78401	240.08	–22.62		2.29	–3.16	B0.3 IV	123 ± 13
77	ε Sco Wei	82396	252.54	–34.29		2.29	0.78	K2.5 III	20.1 ± 0.3
78	ε Cen	66657	204.97	–53.47	1	2.29	–3.02	B1 III	115 ± 10
79	α Lup	71860	220.48	–47.39	1	2.30	–3.83	B1.5 III	168 ± 20
80	η Cen	71352	218.88	–42.16	*	2.33	–2.55	B1.5 V	95 ± 7
81	β UMa Merak	53910	165.46	56.38		2.34	0.41	A1 V	24.3 ± 0.4
82	ε Boo Izar	72105	221.25	27.07	1+2	2.35	–1.69	K0 II-III + A0 V	64 ± 3
83	ε Peg Enif	107315	326.05	9.88	*	2.38	–4.19	K2 I	206 ± 35
84	κ Sco	86670	265.62	–39.03		2.39	–3.38	B1.5 III	142 ± 15

	Name	HIP[a]	RA[b]/degrees	Dec[b]/degrees	Bin[c]	V[d]	M_V[e]	Sp type[f]	d/pc[g]
85	α Phe Ankaa	2081	6.57	–42.31		2.40	0.52	K0 III	23.7 ± 0.5
86	γ UMa Phad	58001	178.46	53.70		2.41	0.36	A0 V	25.6 ± 0.4
87	η Oph	84012	257.59	–15.73	1	2.43	0.37	A0 V	25.8 ± 0.6
88	β Peg Scheat	113881	345.94	28.08	1 *	2.44	–1.49	M2.5 II-III	61 ± 3
89	α Cep Alderamin	105199	319.64	62.59	1	2.45	1.58	A7 V	15.0 ± 0.1
90	η CMa Aludra	35904	111.02	–29.30	1	2.45	–7.51	B5 I	980 ± 550
91	κ Vel Cih	45941	140.53	–55.01		2.47	–3.62	B2 IV-V	165 ± 13
92	ε Cyg	102488	311.55	33.97	1	2.48	0.76	K0 III	22.1 ± 0.3
93	α Peg Markab	113963	346.19	15.21		2.49	–0.67	B9 V	42.8 ± 1.4
94	ζ Oph	81377	249.29	–10.57		2.54	–3.20	O9.5 V	140 ± 14
95	α Cet Menkar	14135	45.57	4.09		2.54	–1.61	M1.5 III	67 ± 4
96	ζ Cen	68002	208.89	–47.29		2.55	–2.81	B2.5 IV	118 ± 10
97	β Sco A	78820	241.36	–19.81	1	2.56	–3.50	B1 V	163 ± 30
98	δ Leo	54872	168.53	20.52	1	2.56	1.32	A4 V	17.7 ± 0.3
99	δ Cen	59196	182.09	–50.72		2.58	–2.84	B2 IV	121 ± 11
100	α Lep Arneb	25985	83.18	–17.82	1	2.58	–5.40	F0 I	390 ± 110

[a]Hipparcos catalogue number.

[b]Coordinate system fixed with respect to the stars. Right Ascension and Declination at the beginning of the year 2000.

[c]Binary or Variable star: 1 = data for brightest component only or brightest component dominates total radiation; 2 = data for fainter component only; 1+2 = data for combined star; * = variable.

[d]Apparent visual magnitude (Section 3.3.3).

[e]Absolute visual magnitude (Section 3.3.3).

[f]Spectral type (Section 3.3.2): W = Wolf–Rayet star.

[g]Distance from the Sun in parsecs.

Data adapted from ESA, The Hipparcos Space Astrometry Mission
http://astro.estec.esa.nl/Hipparcos

APPENDIX A5
THE CHEMICAL ELEMENTS AND THEIR ABUNDANCES

The relative abundance for hydrogen is arbitrarily set at 10^{12}. The relative atomic mass, A_r, is the average mass of the atoms of the element as it occurs on Earth. It is thus an average over all the isotopes of the element. The scale is fixed by giving the carbon isotope $^{12}_{6}C$ a relative atomic mass of 12.0.

Atomic number, Z	Name	Chemical symbol	Relative atomic mass, A_r	Solar System abundance by number	by mass
1	hydrogen	H	1.01	1.0×10^{12}	1.0×10^{12}
2	helium	He	4.00	9.8×10^{10}	3.9×10^{11}
3	lithium	Li	6.94	2.0×10^{3}	1.4×10^{4}
4	beryllium	Be	9.01	26	2.4×10^{2}
5	boron	B	10.81	6.3×10^{2}	6.8×10^{3}
6	carbon	C	12.01	3.6×10^{8}	4.4×10^{9}
7	nitrogen	N	14.01	1.1×10^{8}	1.6×10^{9}
8	oxygen	O	16.00	8.5×10^{8}	1.4×10^{10}
9	fluorine	F	19.00	3.0×10^{4}	5.7×10^{5}
10	neon	Ne	20.18	1.2×10^{8}	2.5×10^{9}
11	sodium	Na	22.99	2.0×10^{6}	4.7×10^{7}
12	magnesium	Mg	24.31	3.8×10^{7}	9.2×10^{8}
13	aluminium	Al	26.98	3.0×10^{6}	8.1×10^{7}
14	silicon	Si	28.09	3.5×10^{7}	1.0×10^{9}
15	phosphorus	P	30.97	3.7×10^{5}	1.2×10^{7}
16	sulfur	S	32.07	1.9×10^{7}	6.0×10^{8}
17	chlorine	Cl	35.45	1.9×10^{5}	6.6×10^{6}
18	argon	Ar	39.95	3.6×10^{6}	1.5×10^{8}
19	potassium	K	39.10	1.3×10^{5}	5.2×10^{6}
20	calcium	Ca	40.08	2.2×10^{6}	8.8×10^{7}
21	scandium	Sc	44.96	1.2×10^{3}	5.5×10^{4}
22	titanium	Ti	47.88	8.5×10^{4}	4.1×10^{6}
23	vanadium	V	50.94	1.0×10^{4}	5.3×10^{5}
24	chromium	Cr	52.00	4.8×10^{5}	2.5×10^{7}
25	manganese	Mn	54.94	3.4×10^{5}	1.9×10^{7}
26	iron	Fe	55.85	3.2×10^{7}	1.8×10^{9}

Atomic number, Z	Name	Chemical symbol	Relative atomic mass, A_r	Solar System abundance by number	by mass
27	cobalt	Co	58.93	8.1×10^4	4.8×10^6
28	nickel	Ni	58.69	1.8×10^6	1.0×10^8
29	copper	Cu	63.55	1.9×10^4	1.2×10^6
30	zinc	Zn	65.39	4.5×10^4	2.9×10^6
31	gallium	Ga	69.72	1.3×10^3	9.4×10^4
32	germanium	Ge	72.61	4.3×10^3	3.1×10^5
33	arsenic	As	74.92	2.3×10^2	1.8×10^4
34	selenium	Se	78.96	2.2×10^3	1.8×10^5
35	bromine	Br	79.90	4.3×10^2	3.4×10^4
36	krypton	Kr	83.80	1.7×10^3	1.4×10^5
37	rubidium	Rb	85.47	2.5×10^2	2.1×10^4
38	strontium	Sr	87.62	8.5×10^2	7.5×10^4
39	yttrium	Y	88.91	1.7×10^2	1.5×10^4
40	zirconium	Zr	91.22	4.1×10^2	3.7×10^4
41	niobium	Nb	92.91	25	2.3×10^3
42	molybdenum	Mo	95.94	91	8.7×10^3
43	technetium	Tc[a]	98.91	–[b]	–[b]
44	ruthenium	Ru	101.07	66	6.8×10^3
45	rhodium	Rh	102.91	12	1.3×10^3
46	palladium	Pd	106.42	50	5.3×10^3
47	silver	Ag	107.87	17	1.9×10^3
48	cadmium	Cd	112.41	58	6.5×10^3
49	indium	In	114.82	6.6	7.6×10^2
50	tin	Sn	118.71	140	1.6×10^4
51	antimony	Sb	121.76	11	1.3×10^3
52	tellurium	Te	127.60	170	2.2×10^4
53	iodine	I	126.90	32	4.1×10^3
54	xenon	Xe	131.29	170	2.2×10^4
55	caesium	Cs	132.91	13	1.8×10^3
56	barium	Ba	137.33	160	2.2×10^4
57	lanthanum	La	138.91	16	2.2×10^3
58	cerium	Ce	140.12	41	5.7×10^3
59	praseodymium	Pr	140.91	6.0	8.5×10^2

Atomic number, Z	Name	Chemical symbol	Relative atomic mass, A_r	Solar System abundance by number	by mass
60	neodymium	Nd	144.24	30	4.3×10^3
61	promethium	Pm[a]	146.92	–[c]	–[c]
62	samarium	Sm	150.36	9.3	1.4×10^3
63	europium	Eu	151.96	3.5	5.3×10^2
64	gadolinium	Gd	157.25	12	1.8×10^3
65	terbium	Tb	158.93	2.1	3.4×10^2
66	dysprosium	Dy	162.50	14	2.3×10^3
67	holmium	Ho	164.93	3.2	5.2×10^2
68	erbium	Er	167.26	8.9	1.5×10^3
69	thulium	Tm	168.93	1.3	2.3×10^2
70	ytterbium	Yb	170.04	8.9	1.5×10^3
71	lutetium	Lu	174.97	1.3	2.3×10^2
72	hafnium	Hf	178.49	5.3	9.6×10^2
73	tantalum	Ta	180.95	1.3	2.4×10^2
74	tungsten	W	183.85	4.8	8.8×10^2
75	rhenium	Re	186.21	1.9	3.5×10^2
76	osmium	Os	190.2	24	4.6×10^3
77	iridium	Ir	192.22	23	4.5×10^3
78	platinum	Pt	195.08	48	9.3×10^3
79	gold	Au	196.97	6.8	1.3×10^3
80	mercury	Hg	200.59	12	2.5×10^3
81	thallium	Tl	204.38	6.6	1.4×10^3
82	lead	Pb	207.2	110	2.3×10^4
83	bismuth	Bi	208.98	5.1	1.1×10^3
84	polonium	Po[a]	209.98	–[c]	–[c]
85	astatine	At[a]	209.99	–[c]	–[c]
86	radon	Rn[a]	222.02	–[c]	–[c]
87	francium	Fr[a]	223.02	–[c]	–[c]
88	radium	Ra[a]	226.03	–[c]	–[c]
89	actinium	Ac[a]	227.03	–[c]	–[c]
90	thorium	Th[a]	232.04	1.2	2.8×10^2

Atomic number, Z	Name	Chemical symbol	Relative atomic mass, A_r	Solar System abundance by number	by mass
91	protoactinium	Pa[a]	231.04	– [c]	– [c]
92	uranium	U[a]	238.03	0.32	7.7×10^{1}
93	neptunium	Np[a]	237.05	– [c]	– [c]
94	plutonium	Pu[a]	239.05	– [c]	– [c]
95	americium	Am[a]	241.06	– [c]	– [c]
96	curium	Cm[a]	244.06	– [c]	– [c]
97	berkelium	Bk[a]	249.08	– [c]	– [c]
98	californium	Cf[a]	252.08	– [c]	– [c]
99	einsteinium	Es[a]	252.08	– [c]	– [c]
100	fermium	Fm[a]	257.10	– [c]	– [c]
101	mendelevium	Md[a]	258.10	– [c]	– [c]
102	nobelium	No[a]	259.10	– [c]	– [c]
103	lawrencium	Lr[a]	262.11	– [c]	– [c]
104	rutherfordium	Rf[a]	261	– [c]	– [c]
105	dubnium	Db[a]	262	– [c]	– [c]
106	seaborgium	Sg[a]	266	– [c]	– [c]
107	bohrium	Bh[a]	264	– [c]	– [c]
108	hassium	Hs[a]	269	– [c]	– [c]
109	meitnerium	Mt[a]	268	– [c]	– [c]
110	ununnilium	Uun[a]	271	– [c]	– [c]
111	unununium	Uuu[a]	272	– [c]	– [c]
112	ununbium	Uub[a]	285	– [c]	– [c]

[a] No stable isotopes.

[b] Detected in spectra of rare evolved stars but has a half-life too short for survival in the interstellar medium.

[c] Far too scarce to have been detected beyond the Earth, and probably very scarce.

Data adapted from Däppen, 2000, from the original data of Ander and Grevesse, 1989, and Grevesse and Noels, 1993.